Prevalence and severity of groin problems in Spanish football

A prospective study beyond the time-loss approach

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PREVALENCE AND SEVERITY OF GROIN PROBLEMS IN SPANISH FOOTBALL: A PROSPECTIVE STUDY BEYOND THE TIME-LOSS APPROACH

Running title: The extent of groin problems in football

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ABSTRACT

The time-loss definition of injury is commonly adopted in epidemiological groin-injury studies in football, with a significant risk of underestimating the impact of these injuries. This study investigated the extent of groin problems, beyond the time-loss approach, over a full Spanish football season.

Players from 17 amateur male teams were followed over 39 consecutive weeks. Groin-injury time loss and self-reported groin pain, irrespective of time loss, were combined to calculate the average weekly prevalence of all groin problems with or without time loss. A subscale measuring hip- and groin-related sporting function from the Copenhagen Hip And Groin Outcome Score questionnaire (HAGOS, Sport/Rec) was registered every 4 weeks.

In total, 407 players participated in the study. The average (range) weekly prevalence of all groin problems was 11.7% (7.2–20.8%); 1.3% with time loss (0.0–3.2%) and 10.4% without time loss (6.3–17.6%). Players with groin problems reported lower scores (mean difference) on the HAGOS, Sport/Rec subscale compared to players without (-19.5 (95% CI: -20.7 – -18.4), while there was no difference between players reporting groin problems with and without time loss (4.0 (95% CI: -1.1 – 9.1).

The traditional time-loss measure only captured 10% of all groin problems. Hip- and groin-related sporting function was not different between players reporting groin problems with or without time loss, suggesting the reason for continuing to play is not only related to the severity of symptoms. These findings question the judicious use of the time-loss approach in overuse conditions, such as groin pain in footballers.

Keywords: groin injury, time-loss, football, groin problems, groin pain, sporting function

INTRODUCTION

Methodologies for registering sports injury are increasingly generating debate among researchers. Novel methods for recording overuse injuries highlight that the traditional time-loss definition severely underestimates the true extent of these injuries.[1–3] Overuse injuries usually present with a gradual onset of symptoms, such as pain or functional limitations, which can fluctuate over time.[2,3] This is often the case for groin injuries, of which 76% have a gradual onset,[4] allowing players to adapt their training, postponing time loss and continuing participation. Despite this, the time-loss definition is commonly used in epidemiological groin-injury studies in football.[5–7]

The number of prospective studies investigating the extent of groin injuries beyond the time-loss approach is low.[5] A Danish study in sub-elite male football, showed that one-third of groin injuries leading to medical attention did not result in time loss.[8] While this "medical attention" approach seems to capture more injuries than the time-loss approach, the availability of medical support will affect the injury rate, making it difficult to compare studies conducted in different settings.[2] Recently, two prospective Norwegian studies investigated the prevalence of groin problems in football using the Oslo Sports Trauma Research Center (OSTRC) Overuse Injury Questionnaire,[9,10] a self-reported method for the registration of overuse problems based on the "any physical complaint" definition.[3] Results showed an average weekly prevalence of groin problems of 21% over a 28-week season,[10] increasing to 29% during a 6-week congested match period.[9] Importantly, only one-third of all groin problems resulted in time-loss in both studies. In summary, these findings provide evidence that the true extent of groin problems is not captured by the time-loss approach, although the current knowledge only relates to northern European football.

Reporting injury severity in terms of time-loss duration from sport has also been questioned. The time-loss definition does not necessarily reflect the extent of symptoms and how function may fluctuate over time.[2,3] The measurement of injury severity should be considered with the level of sports-related function, such as reduced sporting performance, and not with time loss alone.[2,3] The Copenhagen Hip And Groin Outcome Score (HAGOS) questionnaire is a patient-reported outcome measure that contains a specific subscale assessing Physical function in Sports and Recreation (HAGOS, Sport/Rec).[11] Importantly, although previous research demonstrates footballers with groin pain exhibit reduced sporting function,[12,13] it is unknown whether the severity of hip and groin symptoms are related to time loss.

Studies investigating the prevalence and severity of groin problems beyond the time-loss approach are lacking in southern European countries. The purpose of this study was to investigate the extent of groin problems in a full Spanish football season (39 weeks). The traditional time-loss approach was used in addition to novel measures for estimating both the prevalence of groin pain, and hip- and groin-related sporting function.

MATERIALS AND METHODS

Study design and participants

During the 2015 pre-season, we invited a convenience sample of 17 male football teams from the northeast of Spain to participate in the study (Table 1). All players training and/or competing in the included teams were potentially eligible for participation. We enrolled players at the beginning of the pre-season and also during the competitive season (if a new player joined a team). Of the 436 potentially eligible players, 8 were under 18 years old; 2 were not able to understand Spanish or English; and 19 had incomplete information (i.e., age unknown; consent not signed).

The reporting of this prospective cohort study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[14] We obtained the present data from a larger study that investigates groin and hamstring injuries in male football.[15] Local ethics committee (*Consell Catala de l'Esport*) approval was received before the study began (reference number 08/2015/CEICEGC). The study protocol was in accordance with the Helsinki Declaration. All players were informed about the purpose and procedures of the study, and written consent was obtained before entering the study.

Data collection

We collected characteristics of the included players at the start of the pre-season (July–August 2015) and when a new player enrolled in the study during the consecutive 39-week follow-up period. Members of the research team recorded player's contact and demographic (age) information using a written form and measured weight and height, respectively, using a digital scale and a portable stadiometer.

Team physiotherapists were responsible for registering the number and characteristics of time-loss groin injuries. Registration included the date of injury, date of return to full participation and the number of missed training sessions and matches due to the groin injury, using a computer-

based injury registration spreadsheet. Team physiotherapists attended at least two training sessions and one match per week. When a team did not have a physiotherapist, one member of the research team was responsible for injury data collection. Members of the technical staff of each team registered whether a player was enrolled with a team, as well as individual and team exposure to football training and matches.

We collected groin-pain information, irrespective of time loss, using three different versions of a structured written survey. After the first match, players revealed whether they had suffered from groin pain (yes/no) in the past week using a 1-week version of the written survey. To minimize the risk of attrition related to answering every week for 39 consecutive weeks, we collected subsequent groin-pain information every 4 weeks. For this purpose, we used a 4-week version of the written survey to ask players whether they suffered from groin pain (yes/no) in any of the past 4 weeks, separately. Lastly, players completed a 2-week version of the written survey in the last week of the season due to the competition calendar. The different versions of the written groin-pain survey can be seen in Supplementary file (Appendix 1).

For every groin-pain survey, players also completed the Sports and Recreation HAGOS subscale (HAGOS, Sport/Rec). The HAGOS is a valid and responsive tool specifically designed to assess hip and groin pain and function, and it contains 6 separate subscales: Pain, Symptoms, Physical Function in Daily Living, Physical Function in Sports and Recreation and Hip- and Groin-related Quality of Life. All HAGOS subscales provide independent scores ranging from 0 to 100, where 0 indicates extreme groin pain and limitations, whilst 100 infers free of symptoms and full function.[11] In this study, we used the translated and cross-culturally-adapted Spanish version of the HAGOS questionnaire (available at www.koos.nu).

In one 4-week period of the competitive season (weeks 34–37), players completed the groin-pain survey every week, instead of every 4 weeks, to compare prevalence estimates of the 4-week approach to the 1-week approach. Operational definitions used in data collection are shown in Table 2.

Outcomes

The primary outcome of this study was the weekly prevalence of all groin problems. All groin problems included groin problems with and without time loss. A player was considered as having a groin problem with time loss when he missed at least one training session or a match due to a groin injury (i.e., “time-loss groin injury”) in a given week. When a player answered “yes” to the

question “Did you have groin pain (inguinal region including adductors, lower abdomen, and pubic region) in the past week?”, but no time loss was reported due to a groin problem in the week in question, the player was considered as having a groin problem without time loss. From this information, players were classified at any given week, as 1) experiencing a groin problem with time loss, 2) experiencing a groin problem without time loss, or 3) not experiencing a groin problem.

As secondary outcomes, we assessed the hip- and groin-related sporting function, using the HAGOS, Sports/Rec subscale. Individual HAGOS, Sport/Rec subscale scores were calculated per player at every time point. We also used information from team injury records on date of injury, and date of return to full participation, to determine all new time-loss groin injury cases.

Data analyses

We calculated the weekly prevalence of groin problems with or without time-loss by dividing the number of players who reported groin problem with and without time loss, respectively, by the number of players who were part of the team at any specific week. Prevalence measures were expressed as a percentage from 0–100%. We used the McNemar test to compare possible differences between prevalence proportions regarding the two frequencies of registration; every week (1-week survey) instead of every fourth week (4-week survey).

To assess differences in the HAGOS, Sports/Rec subscale 1) between players reporting groin problems and players not reporting groin problems, and 2) between players reporting groin problems with and without time loss, respectively, we performed linear mixed models (LMMs). Groin problem (yes/no) or time-loss (yes/no) and week number were included as fixed effects, while players and week number were considered as nested random effects. The HAGOS, Sports/Rec score was set as the dependent variable. The significance of the fixed effects associated with the covariate included in the model was assessed using the Wald tests. Homogeneity and normality were checked via q-q normal graphs of residuals. Although HAGOS, Sports/Rec scores demonstrated some deviation from normality, fixed-effect estimates are known to be robust under heavy-tailed conditions.[16] Descriptive of HAGOS, Sport/Rec subscale scores were plotted as raincloud plots.[17]

We calculated the incidence of time-loss groin injuries with 95% confidence intervals (95% CI) using the Poisson distribution, as the number of new time-loss groin injuries per 1000 hours of exposure to football. The burden of time-loss groin injury is expressed as the number of lost days

per 1.000 hours of football exposure and calculated by dividing the sum of missed days due to a groin injury by the total number of hours with football exposure.[18]

Analyses were performed using statistical software IBM SPSS statistics 25.0 and R (The R Foundation for Statistical Computing, Vienna, Austria), R version 3.3.2 (R Core Team, 2016), with the package nlme[19] and lmerTest.[20] The ggplot2 R package was used for graphical representation.[21] A p-value below 0.05 was considered significant in all analyses. All players participating in the study were included in the analyses as long as they were part of one of the included teams.

RESULTS

The average response rate from the 407 participants to the groin-pain survey was 93.3% (range: 89.2–95.4%). During the study period, a total of 216 (53.1%) players reported a groin problem. The average weekly prevalence of all groin problems was 11.7% (range: 7.2–20.8%), consisting of 1.3% groin problems with time loss (range: 0.0–3.2%) and 10.4% without time loss (range: 6.3–17.6%). Prevalence of all groin problems across the 39 weeks is shown in Figure 1. Details of frequencies of groin problems with or without time loss across the 39 weeks can be seen in the Supplementary file (Appendix 2). There were no significant differences in groin-pain prevalence when collecting data every week or every fourth week. Sampling more frequently (every week instead of every 4 weeks) was, however, related to lower response rates (ranges: 74.8–75.5% vs 94.7–95.5%). Effects on groin-pain prevalence rates using the two different registration methods are shown in Table 3.

Descriptive HAGOS, Sport/Rec subscale scores are shown in Figure 2. Players reporting any groin problem showed lower HAGOS, Sports/Rec subscale scores compared to players not reporting groin problems (mean difference: (-19.5 (95% CI: -20.7 – -18.4), $p < 0.001$). There was no difference in Sports/Rec HAGOS subscale scores between players reporting groin problem with or without time loss (mean difference: 4.0 (95% CI: -1.1 – 9.1), $p = 0.12$). Details of the estimates of the LMMs can be seen in the Supplementary file (Appendix 3).

Individual exposure could not be calculated as this data was inconsistent from two teams. Team reported a total of 71,908 hours of football exposure and registered 63 time-loss groin injuries. Incidence of time-loss groin injuries was 0.9 (95% CI 0.8 to 1.0) per 1000 hours of

football exposure. The overall burden of time-loss groin injury was 8.6 days lost per 1000 hours of football exposure.

DISCUSSION

We found an average weekly prevalence of groin problems of 11.7% during the 39-week competitive period. On a weekly basis, 1.3% of players reported groin problems with time loss, while 10.4% reported groin problems without time loss. The present study also evaluated hip- and groin-related sporting function using the HAGOS, Sport/Rec subscale,[11] and showed that players reporting groin problems had lower HAGOS, Sport/Rec scores compared to players without groin problems. These results demonstrate that despite causing pain and significant impairments in sporting function, the majority of groin problems do not lead to time loss. Importantly, this study also showed no difference in the hip- and groin-related sporting function between players reporting groin problems with and without time loss. Therefore, if we focus on time loss as a measure of severity in football players with groin problems, we may be underestimating the impact of these injuries.

The high seasonal prevalence of groin problems identified in the present study (53.1%) confirms previous findings.[4,9,10,13] However, the reported average weekly prevalence of groin problems was lower in this Spanish cohort (12%) compared to previously-reported prospective Norwegian studies (21–29%).[9,10] This reported difference may be due to a methodological difference in data collection, as the Norwegian studies included other complaints, such as aches, stiffness, or swelling, in addition to pain when registering groin problems. The Norwegian approach may, therefore, capture more complaints, as only pain was recorded in the present Spanish study.

The highest weekly prevalence of groin problems in the Norwegian studies appears to be during match congestion in the early season when it reached 29%.[9] Load spikes, and accumulated training loads have both been associated with increased injury risk in professional football.[22] This present study on Spanish football showed the highest weekly prevalence of groin problems (20.8%) was in the first week of the competitive period. During the first week, training schedules were similar to the rest of the season, but accumulated training loads during the preceding weeks (the pre-season) could be a possible explanation for the increased prevalence of groin problems at this stage. In football, injury risk appears to be related to both training loads and phase, placing

players at a higher risk during the pre-season compared to the in-season despite similar training loads.[22] After the lack of sport-specific training during the off-season, players are commonly exposed to higher training loads in the pre-season,[23] increasing the risk of groin injuries at the beginning of a new season.[22,24] Current evidence suggests the prevalence of groin problems during the pre-season may be close to 35%.[10,13] Differences in the prevalence of groin problems between the pre-season and in-season periods should be investigated in future studies, as a high proportion of players develop symptoms before the competition starts. This indicates that preventative interventions should be implemented early within the season, or even before the start of pre-season during the off-season.

It has been suggested that the severity of injuries should be measured based on the level of sports-related function, and not only on time-loss duration.[2] This study is to our knowledge, one of the first studies to investigate if time loss *per se* is related to a reduced sporting function due to groin problems. We found no difference in the HAGOS, Sport/Rec subscale between players reporting groin problems with and without time loss, suggesting time loss is not related to hip- and groin-related sporting function. This also indicates that football players continue playing regardless of having their sporting function impaired, which fits well with the clinical experience, that players with severe overuse symptoms may ignore such symptoms and continue to play. Evidence from social sciences has suggested that injured football players decide to continue to play for several reasons mainly related to economic aspects or football player idiosyncrasy, such as a sense of guilt of being injured or pressure to continue playing from managers.[25,26] As time loss is not related to hip- and groin-related sporting function, it seems highly relevant to implement other tools to rate injury severity, and for this purpose, the HAGOS questionnaire has also been validated in footballers.[11] Implementation of the HAGOS questionnaire during the season would allow for close monitoring of player's function and early detection of abnormal scores.[27] Due to the high prevalence of on-going groin problems, future interventions should aim not only at preventing new groin problem episodes but also at reducing pain and the duration of symptoms of already existing problems. Strength-training interventions for the hip adductor muscles have been proven effective in both reducing the prevalence of groin problems,[10] and as a treatment of long-standing groin pain cases,[28] the implementation of such interventions seems highly relevant.

We found a time-loss groin injury incidence of 0.9/1000 hours, with an overall burden of 8.6 days lost/1000 hours. Although the inclusion of data on injury burden along with incidence

measures has been recommended for epidemiological studies, it has limitations when injuries do not lead to time loss.[29] As clearly illustrated in the present study, where the time-loss definition only captured 10% of all groin problems, our results emphasized that reporting prevalence and severity measures seem more appropriate for groin problems.

Methodological considerations and limitations

We are aware of the risk of selection and recall bias. The generalization of the present results should, therefore, be made with caution. Although we conducted this present study in a convenience sample, teams participating were from similar levels of football and therefore equally exposed (Table 1), and importantly, none of the invited teams refused to participate. Hence, it seems reasonable to believe that the results obtained in this present cohort would not differ from a random sample. To minimize recall bias, all written surveys provided specific information regarding the dates and match opponents in the required weeks. Players who failed to complete any type of survey and/or questionnaire were asked to complete it during the subsequent week. When this was not successful, it was considered a missed response.

During the study period, 26 players changed team among the 17 teams participating in the study. Of the 89 players that dropped out during follow-up, 47 changed to another team not participating in the study; 17 ended their sports career; 14 suffered a long-term injury; and for 11 players, the reason could not be determined. Due to this high mobility of players between teams, the sample of this study was dynamic, and the number of players included was calculated per every week. See supplementary file (Appendix 2). We do not consider this as a weakness, as estimated proportions would be representative of a weekly prevalence of groin problems in a given competitive week during a male football season. As previously mentioned, players were included in the study only if they were part of the included teams. A player being "part of the team" in a given week, refers to a player enrolled with a team at least one day, independently of whether they answered the written groin-pain survey. We found this approach more prudent than other calculations previously reported, using number of cases/number of respondents.[3,9] Using our calculation, prevalence might be slightly underestimated but is unlikely to be overestimated, as we are assuming that non-respondents would have answered "no" to the written groin-pain surveys. However, any bias on our estimates is expected to be minimal due to the high response rate in the present study.

Measurement properties, including validity, reliability, and responsiveness of the Spanish HAGOS used in this study have not been evaluated. However, the Spanish version of HAGOS was cross-culturally adapted from the original Danish, and the English versions according to existing guidelines[30] by members of this research group. During the process of cross-cultural adaptation, the preliminary Spanish HAGOS was tested on football players from a similar cohort and all issues related to cultural and linguistic differences were solved. Details on the cross-cultural adaptation to Spanish can be found at www.koos.nu.

Conclusion

Groin problems were highly prevalent in this study, affecting more than one in every two players during the football season. On a weekly average, one in every ten players experienced groin problems and a reduced sporting function but most players continue to participate. The hip- and groin-related sporting function, as measured by the HAGOS, Sport/Rec subscale, was not associated with time loss. In essence, this supports previous findings that the extent of the groin-injury problem in a male football season is much larger than what the time-loss definition approach is able to capture.

Perspectives

We found a high seasonal prevalence of groin problems, but only one-tenth resulted in weekly time loss from football. It, therefore, seems that previous epidemiological studies using the time-loss definition have greatly underestimated the true extent of these injuries. This has strong implications for future studies, especially those aimed at risk factor identification and groin-injury prevention. Studies using the time-loss definition for groin injuries have a low event rate, which makes it difficult to detect if any differences in incidences exist and only targets what seems to be a small fraction of the actual problem.[31]

Our findings also support new perspectives of studying the sports-injury problem, as despite experiencing pain and sporting function limitations, most players decide to continue to play. This emphasizes the need for contextualization of sports-injury definitions, including not only perspectives from athletes and researchers, but also from coaches and clinicians, as these are fundamental for implementing successful injury prevention interventions.[32–34]

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work, design, analyses, and interpretation of the data. The authors JB and AP have contributed together with the first author (EE) in data collection, as well as interpretation of the data. Author MC contributed in analyses, and visualization and interpretation of the data. All authors have participated in writing the paper and revising it critically for important intellectual content, as well as the final approval of the version to be published.

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REFERENCES

1. Fuller CW, Ekstrand J, Junge A, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Br J Sports Med*. 2006;40(3):193-201. doi:10.1136/bjsm.2005.025270

2. Bahr R. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. *Br J Sports Med*. 2009;43(13):966-972. doi:10.1136/bjsm.2009.066936

3. Clarsen B, Myklebust G, Bahr R. Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology: the Oslo Sports Trauma Research Centre (OSTRC) overuse injury questionnaire. *Br J Sports Med*. 2013;47(8):495-502. doi:10.1136/bjsports-2012-091524

4. Karlsson MK, Dahan R, Magnusson H, Nyquist F, Rosengren BE. Groin pain and soccer players: male versus female occurrence. *J Sports Med Phys Fitness*. 2014;54(4):487-493.

5. Waldén M, Hägglund M, Ekstrand J. The epidemiology of groin injury in senior football: a systematic review of prospective studies. *Br J Sports Med*. 2015;49(12):792-797. doi:10.1136/bjsports-2015-094705

6. Mosler AB, Weir A, Eirale C, et al. Epidemiology of time loss groin injuries in a men's professional football league: a 2-year prospective study of 17 clubs and 606 players. *Br J Sports Med*. 2018;52(5):292-297. doi:10.1136/bjsports-2016-097277

7. Werner J, Hägglund M, Ekstrand J, Waldén M. Hip and groin time-loss injuries decreased slightly but injury burden remained constant in men's professional football: the 15-year prospective UEFA Elite Club Injury Study. *Br J Sports Med*. 2019;53(9):539-546. doi:10.1136/bjsports-2017-097796

8. Hölmich P, Thorborg K, Dehlendorff C, Krogsgaard K, Gluud C. Incidence and clinical presentation of groin injuries in sub-elite male soccer. *Br J Sports Med*. 2014;48(16):1245-1250. doi:10.1136/bjsports-2013-092627

9. Harøy J, Clarsen B, Thorborg K, Hölmich P, Bahr R, Andersen TE. Groin Problems in Male Soccer Players Are More Common Than Previously Reported. *Am J Sports Med*. 2017;45(6):1304-1308. doi:10.1177/0363546516687539

10. Harøy J, Clarsen B, Wiger EG, et al. The Adductor Strengthening Programme prevents groin problems among male football players: a cluster-randomised controlled trial. *Br J Sports Med*. 2019;53(3):150-157. doi:10.1136/bjsports-2017-098937

11. Thorborg K, Hölmich P, Christensen R, Petersen J, Roos EM. The Copenhagen Hip and Groin Outcome Score (HAGOS): development and validation according to the COSMIN checklist. *Br J Sports Med*. 2011;45(6):478-491. doi:10.1136/bjsm.2010.080937

12. Nevin F, Delahunt E. Adductor squeeze test values and hip joint range of motion in Gaelic football athletes with longstanding groin pain. *J Sci Med Sport*. 2014;17(2):155-159. doi:10.1016/j.jsams.2013.04.008

13. Thorborg K, Rathleff MS, Petersen P, Branci S, Hölmich P. Prevalence and severity of hip and groin pain in sub-elite male football: a cross-sectional cohort study of 695 players. *Scand J Med Sci Sports*. 2017;27(1):107-114. doi:10.1111/sms.12623

14. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet Lond Engl*. 2007;370(9596):1453-1457. doi:10.1016/S0140-6736(07)61602-X

15. Esteve E, Rathleff MS, Vicens-Bordas J, et al. Preseason Adductor Squeeze Strength in 303 Spanish Male Soccer Athletes: A Cross-sectional Study. *Orthop J Sports Med*. 2018;6(1):2325967117747275. doi:10.1177/2325967117747275

16. Jacqmin-Gadda H, Sibillot S, Proust C, Molina J-M, Thiébaut R. Robustness of the linear mixed model to misspecified error distribution. *Comput Stat Data Anal*. 2007;51(10):5142-5154. doi:10.1016/j.csda.2006.05.021

17. Allen M, Poggiali D, Whitaker K, Marshall TR, Kievit RA. Raincloud plots: a multi-platform tool for robust data visualization. *Wellcome Open Res*. 2019;4:63. doi:10.12688/wellcomeopenres.15191.1

18. Ekstrand J, Waldén M, Hägglund M. Hamstring injuries have increased by 4% annually in men's professional football, since 2001: a 13-year longitudinal analysis of the UEFA Elite Club injury study. *Br J Sports Med*. 2016;50(12):731-737. doi:10.1136/bjsports-2015-095359

19. Pinheiro, Jose, Bates, Douglas, DebRoy, Saikat, Deepayan, Sarkar, the R core team. *Nlme: Linear and Nonlinear Mixed Effects MOdels*. R package version 3.1-96; 2009.

20. Kuznetsova A, Brockhoff PB, Christensen RHB. lmerTest Package: Tests in Linear Mixed Effects Models. *J Stat Softw*. 2017;82(1):1-26. doi:10.18637/jss.v082.i13

21. Wickham H. *Ggplot2: Elegant Graphics for Data Anlysis*. Springer-Verlag New York; 2016. http://ggplo2.tidyverse.org.

22. Malone S, Owen A, Newton M, Mendes B, Collins KD, Gabbett TJ. The acute:chonic workload ratio in relation to injury risk in professional soccer. *J Sci Med Sport*. 2017;20(6):561-565. doi:10.1016/j.jsams.2016.10.014

23. Junge A, Dvorak J, Rösch D, Graf-Baumann T, Chomiak J, Peterson L. Psychological and sport-specific characteristics of football players. *Am J Sports Med*. 2000;28(5 Suppl):S22-28.

24. Whittaker JL, Small C, Maffey L, Emery CA. Risk factors for groin injury in sport: an updated systematic review. *Br J Sports Med*. 2015;49(12):803-809. doi:10.1136/bjsports-2014-094287

25. Roderick M. Adding insult to injury: workplace injury in English professional football. *Sociol Health Illn*. 2006;28(1):76-97. doi:10.1111/j.1467-9566.2006.00483.x

26. Roderick M, Waddington I, Parker G. PLAYING HURT: Managing Injuries in English Professional Football. *Int Rev Sociol Sport*. 2000;35(2):165-180. doi:10.1177/101269000035002003

27. Wollin M, Thorborg K, Welvaert M, Pizzari T. In-season monitoring of hip and groin strength, health and function in elite youth soccer: Implementing an early detection and management strategy over two consecutive seasons. *J Sci Med Sport*. 2018;21(10):988-993. doi:10.1016/j.jsams.2018.03.004

28. Hölmich P, Uhrskou P, Ulnits L, et al. Effectiveness of active physical training as treatment for long-standing adductor-related groin pain in athletes: randomised trial. *Lancet Lond Engl*. 1999;353(9151):439-443. doi:10.1016/S0140-6736(98)03340-6

29. Bahr R, Clarsen B, Ekstrand J. Why we should focus on the burden of injuries and illnesses, not just their incidence. *Br J Sports Med*. 2018;52(16):1018-1021. doi:10.1136/bjsports-2017-098160

30. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine*. 2000;25(24):3186-3191. doi:10.1097/00007632-200012150-00014

31. Esteve E, Rathleff MS, Bagur-Calafat C, Urrútia G, Thorborg K. Prevention of groin injuries in sports: a systematic review with meta-analysis of randomised controlled trials. *Br J Sports Med*. 2015;49(12):785-791. doi:10.1136/bjsports-2014-094162

32. Bolling C, Delfino Barboza S, van Mechelen W, Pasman HR. How elite athletes, coaches, and physiotherapists perceive a sports injury. *Transl Sports Med*. 2019;2(1):17-23. doi:10.1002/tsm2.53

33. Bolling C, van Mechelen W, Pasman HR, Verhagen E. Context Matters: Revisiting the First Step of the "Sequence of Prevention" of Sports Injuries. *Sports Med Auckl NZ*. 2018;48(10):2227-2234. doi:10.1007/s40279-018-0953-x

34. Verhagen E, Voogt N, Bruinsma A, Finch CF. A knowledge transfer scheme to bridge the gap between science and practice: an integration of existing research frameworks into a tool for practice. *Br J Sports Med*. 2014;48(8):698-701. doi:10.1136/bjsports-2013-092241

Table 1 Demographic characteristics and exposure of participants

Competitive level (tier)	Teams (n)	Players (n)	Age (y)	Weight (Kg)	Height (cm)	Exposure (h)
3rd national (IV)	5	111	25 (4)	75 (7)	179 (6)	6 (1)
1st regional (V)	5	124	23 (8)	75 (8)	179 (7)	6 (2)
2nd regional (VI)	7	172	23 (4)	73 (8)	177 (6)	5 (1)
Overall	17	407	23 (4)	74 (7)	178 (6)	6 (1)

Values provided as mean (SD). Exposure is expressed as average (SD) of hours of football per team/week.

Table 2 Operational definitions in data collection

Training exposure	Number of hours each team was involved in physical activity under the supervision of the coaching staff
Match exposure	Number of hours each team played in competitive or friendly match against another team
Time-loss groin injury	Any complaint located to the groin (junction between the anteromedial part of the thigh, including the proximal part of the hip adductor muscle bellies, the lower abdomen, and pubic region) leading to a player being unable to fully participate in future training or match play
Number of missed days	Number of days that elapsed from the date of groin injury to the date the injury was resolved and the player returned to full participation in team training and/or availability for match selection
Reinjury	An injury of the same type and at same location as an index injury, and which occurs within two months after a player's return to full participation
Groin Pain	Pain in the inguinal region, including the proximal part of the hip adductor muscles and the lower abdomen and pubic region.

Fuller et al.[1] Werner et al.[7]

Table 3 Effects on prevalence rates with different sampling frequencies

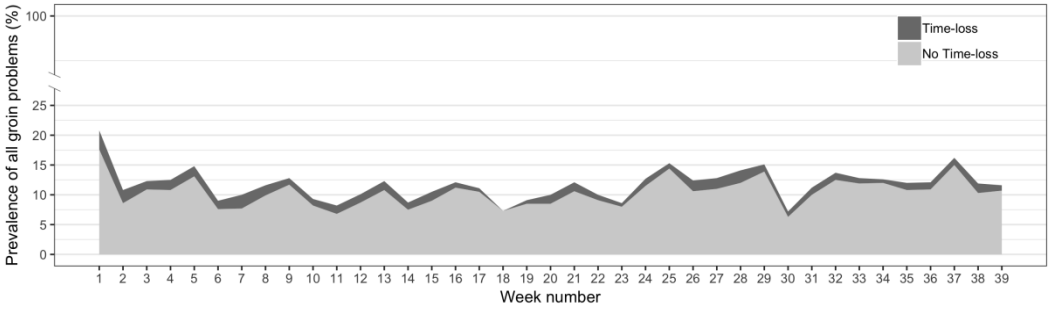
Week number	N	LF (% response)	HF (% response)	*p*-value
34	325	12.6 (95.5)	11.7 (74.8)	1.0
35	323	11.8 (94.7)	12.1 (75.2)	0.07
36	322	11.8 (95.0)	10.2 (75.5)	1.0

LF: Lower Frequency, four-weeks structured questionnaire about groin pain in the past four weeks; HF: Higher Frequency, one-week structured questionnaire asking about groin pain in the past week. Values are prevalence proportions otherwise other indicated.

Figure 1 Weekly prevalence of all groin problems, time-loss and no time-loss groin problems across the 39 competitive weeks.

Figure 2a Raincloud plot with box plots of HAGOS Sport/Rec subscale scores from players reporting groin problems and players not reporting groin problems.

Figure 2b Raincloud plot with box plots of HAGOS, Sport/Rec subscale scores from players reporting time-loss and no time-loss groin problems.



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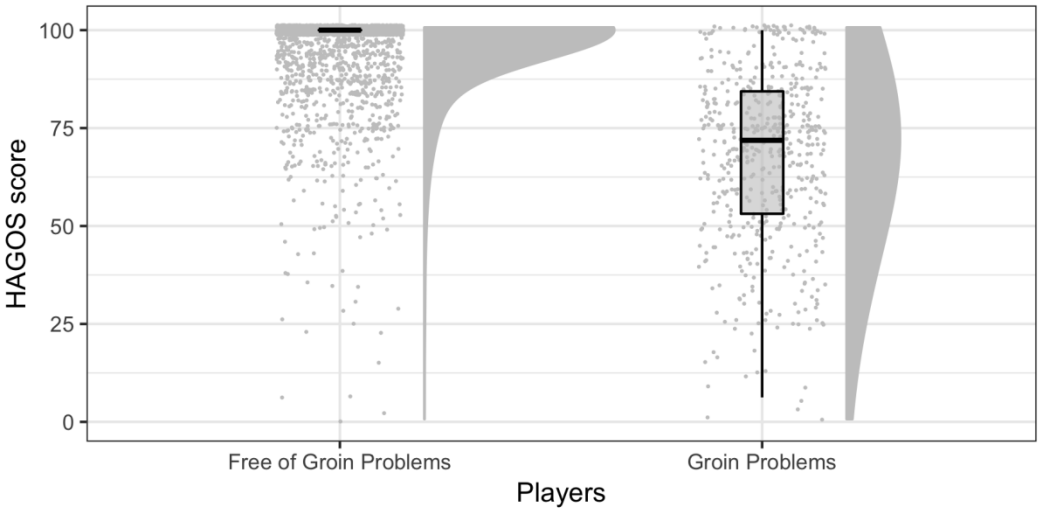

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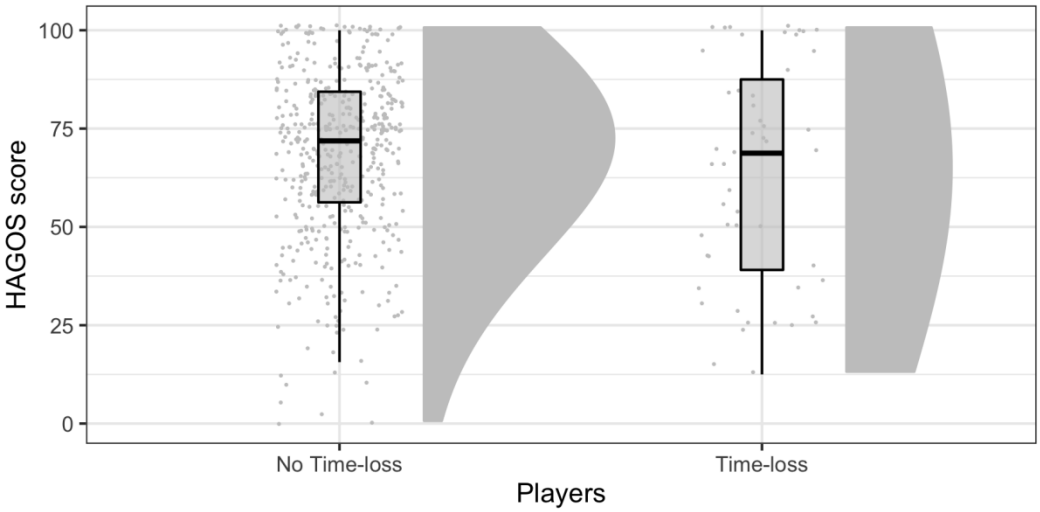

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